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(54) HUMIDIFIER

(71) We, TELECTRONICS PTY LIMITED, a company incorporated under the laws of the State of New South Wales, Commonwealth of Australia, of 2 Sirius Road, Lane Cove, New South Wales, Australia, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to medical humidifiers. During artificial respiration or anaesthesis with a non-rebreathing circuit, dry gases are necessary to prevent icing in the pressure regulators. The human nose can usually humidify the incoming gases, which therefore reach the lung fully saturated with water vapour at body temperature. This function is lost when an endotracheal or tracheostomy tube conveys the dry gases directly to the trachea. Drying of secretions and tissue damage may follow, if a humidifier is not inserted into the conveying hose between the mechanical respirator and the patient requiring long-term ventilation.

Inspiration of dry gases is followed by expiration of saturated warm gases, and this heat loss potentiates any tendency for a decrease in body temperature. Hypothermia in patients during operative surgery can usually be prevented by heated humidification of the gas prior to inhalation.

Humidifiers normally employed for this purpose comprise an electrically heated water bath in an evaporation chamber, through which a gas stream passes, and so becomes humidified before being conveyed by a hose or tube to the patient.

At normal ambient temperatures, a marked temperature drop occurs in the conveying tube. If the gas stream is to reach the patient at body temperature, the temperature of the water bath must be well above that figure. Reduction of heat loss in transit enables lower, and therefore safer, water bath temperatures to be employed. Apart from shortening or lagging a standard one metre length tube, the heat loss is usually made up by adding a separate hose heating system. This has been achieved by wrapping the tube with an electrically heated element, by inserting a sheathed heating wire into the lumen of the tube, or by use of a co-axial double-lumen tube, of which the outer lumen carries a stream of heated air or water.

Thus, in existing systems, two independent heat sources are employed respectively to heat the humidifier and to make up for heat lost to the environment.

For the wellbeing of the patient and to satisfy certain regulations in respect of the gas stream temperature, it is highly desirable that the temperature of the gas stream at the point of entry to the patient should be monitored.

An object of the invention is to provide a comparatively simple and easily monitored humidifier.

The invention consists in a humidifier for respiratory use, comprising a flexible conveying tube for conveying a gas or air stream to a patient, one end of said conveying tube adapted to connect to medical devices providing access to the respiratory passage of said patient, the opposite end of said conveying tube adapted to connect to a ventilating machine or an alternative source of gas or air, the conveying tube enclosing absorbent material adapted to contain water and humidify the flow of gas or air through the tube by evaporation, said absorbent material extending over substantially the entire length of said conveying tube, heating means to heat the flow of gas or air through the conveying tube to the body temperature of the patient, said heating means extending over

substantially the entire length of said conveying tube, and the lumen of said conveying tube having a cross sectional area sufficient to accommodate said absorbent material and allow the flow therethrough of said gas or air.

The invention also consists in a humidifier as described in the preceding paragraph, further comprising at or near the patient end of said conveying tube means effective to sense the temperature of said gas or air, said sensing means being further effective to control the rate of heating of said gas or air by said heating means.

In humidifiers according to this invention, the water bath in the existing system is omitted. Evaporation water into the gas stream takes place in the lumen of the conveying tube. Only one heating source is therefore necessary for heating the gas stream and for compensating for heat loss during transit thereof.

The conveying tube may be made of polyvinyl chloride or other suitable heat insulating material. The absorbent material may be in the form of a tube, rod or strip.

According to one embodiment of the invention, the water absorbent material, in use, is wetted with water. An elongated sheathed electrical heating element extends longitudinally inside the tube for heating the gas stream passing therethrough. Thus, as the gas is being conveyed along the tube, water is taken up by the gas stream which is thereby humidified.

In another embodiment of the invention, the water absorbent material is in the form of a tube enclosing the electrical heating element. A water absorbent tube is loosely placed longitudinally within the conveying tube. In use, water held in the absorbent tube is heated up by the heating element and so evaporates into the gas stream.

In still other embodiments, the conveying tube is lined on its inner wall with a layer of water absorbent material. Heating means are provided on the outside of the conveying tube, and may comprise an electrical heating element wrapping round the conveying tube, or a hot water or gas jacket enclosing the same, which jacket may be heated by one or more electrical elements.

Initial wetting of the water absorbent material may be performed by rinsing that material with distilled water prior to use. Subsequent amounts may be added by way of a bacterial filter either by continuous gravity feed or by intermittent hypodermic injection.

For reasons already stated, it is highly preferable to provide a monitoring unit, which may be mounted on the outlet end of the conveying tube. The unit may comprise a spigot or a short length of tube coupled with the conveying tube, and carrying a temperature sensing element disposed in the path of the gas stream. The sensing element is connected to controlling means adapted to alter the rate of heating of the electric heating element in response to a signal from the sensing element. In this embodiment, water is supplied into the absorbent lining by a nozzled feed tube embedded in the lining and having its inlet end emerging from the wall of the spigot. The terminals of the electrical heating element may also be mounted on the wall of the spigot so that the monitoring unit serves also as a connector for water and power supply.

A humidity sensor may also be included in the monitoring unit to measure the humidity of the gas stream. Normally, humidity is controlled by adjusting the temperature of the gas stream for a fixed flow rate thereof, and the humidity sensor is largely for monitoring purposes.

A gas pressure or an oxygen concentration detector may also be installed in the monitoring unit.

For preference the sensors and detectors are connected to appropriate meters or other display mechanisms wherefrom the relevant quantities may be directly ascertained. Warning systems may also be connected to the various sensors so that an alarm is set off when there is any major fall in humidity or failure of the ventilator or gas supply to provide adequate pressure for ventilation.

The necessary controls, alarm systems and display units may be installed in a central control unit to facilitate operation of the humidifier.

By way of example, a preferred embodiment of the invention is described with reference to the drawing herewith, which is a diagrammatic, medial cross section of a humidifier according to the invention.

The illustrated humidifier comprises a flexible conveying tube 1 linking an inlet housing 2 and a monitor housing 3. Preferably, tube 1 is composed of plastics material, and is convoluted to allow greater flexibility without obstructing flow by kinking. Dry medical gases, from a cylinder (not shown) enter inlet housing 2 at port 4 and pass via tube 1 to monitor housing 3 and beyond that housing to the patient. An elongated, absorbent tube 5 lies loosely within conveying tube 1. Water inlet means, shown as funnel 6, allow sterile distilled water to be supplied to tube 5.

An insulated resistance wire 7 is located within absorbent tube 5, and serves to heat gases flowing through the humidifier. Terminals 8 of the resistance wire 7 are connected to a control unit (not shown) which supplies electrical current thereto.

Located within the monitor housing are a temperature sensor 9 and a humidity sensor 10. Each of these is connected via its respective terminals 11, 12 to the control unit (not shown). In this embodiment, supply of current to resistance wire 7 is controlled by temperature sensor 9, and the humidity sensor merely provides a visual readout. Humidity is dependent on both flow rate and temperature of the gases, and it will be realised that either of these parameters may be varied by the control unit to effect the desired conditions of humidity and temperature.

WHAT WE CLAIM IS:—

1. A humidifier for respiratory use, comprising a flexible conveying tube for conveying a gas or air stream to a patient, one end of said conveying tube adapted to connect to medical devices providing access to the respiratory passage of said patient, the opposite end of said conveying tube adapted to connect to a ventilating machine or an alternative source of gas or air, the conveying tube enclosing absorbent material adapted to contain water and humidify the flow of gas or air through the tube by evaporation, said absorbent material extending over substantially the entire length of said conveying tube, heating means to heat the flow of gas or air through the conveying tube to the body temperature of the patient, said heating means extending over substantially the entire length of said conveying tube, and the lumen of said conveying tube having a cross sectional area sufficient to accommodate said absorbent material and allow the flow therethrough of said gas or air.

2. A humidifier in accordance with Claim 1 further comprising at or near the patient end of said conveying tube means effective to sense the temperature of said gas or air, said sensing means being further effective to control the rate of heating of said gas or air by said heating means.

3. A humidifier according to Claim 1 or Claim 2 wherein said heating means comprises an electrical element within the lumen of said conveying tube.

4. A humidifier according to Claim 1 or Claim 2 wherein said heating means comprises a fluid jacket surrounding said conveying tube said fluid jacket heated by one or more electrical elements.

5. A humidifier according to Claim 1 or Claim 2 wherein said heating means comprises an electrical element wrapped around the conveying tube.

6. A humidifier according to any preceding claim wherein said absorbent material lines the interior wall of said conveying tube.

7. A humidifier according to any one of claims 1 to 5, wherein said absorbent material is in the form of a rod or strip within said conveying tube.

8. A humidifier according to any preceding claim further comprising means for replenishing water evaporated from said absorbent material while the humidifier is in use.

9. A humidifier for respiratory use, substantially as described herein with reference to the accompanying drawing.

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1 SHEET

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.